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GB 700970
GB 626222
GB 568902
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(54) Piston packing for shock-absorber

(57) A cylinder/piston device, such as a shock absorber, comprises a piston 106 defining two working chambers 107*a* and 107*b* within a cylinder 102. The working chambers are in throttled fluid communication with one another through orifices (not shown) within the piston. The piston has an outer annular recess in which is housed a piston ring 112 of resilient material. An annular chamber 111 between the piston and the piston ring is in fluid communication with one or other of the working chambers *via* apertures 115 and 115*a*. When the piston moves pressure in the annular chamber acts radially outwardly on the resilient piston ring thereby urging it into sealing contact with the cylinder. In Fig. 1a the additional sealing ring 113 moves up when the piston moves down and *vice versa* to to alternately close apertures 115 and 115*a*.

FIG.1A

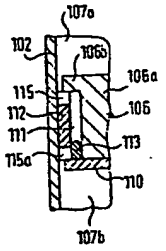

FIG. 2

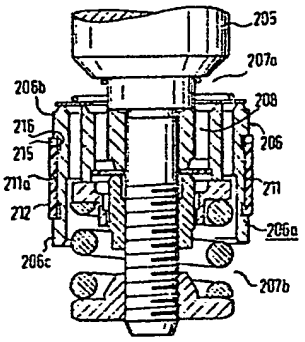

FIG.4

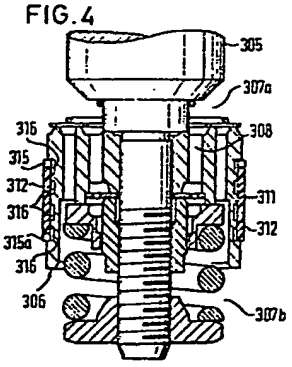

FIG.6

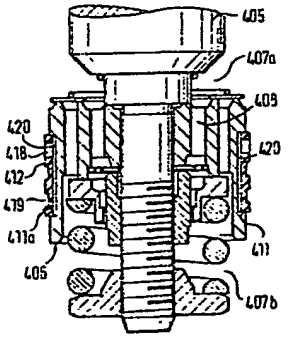

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FIG.1

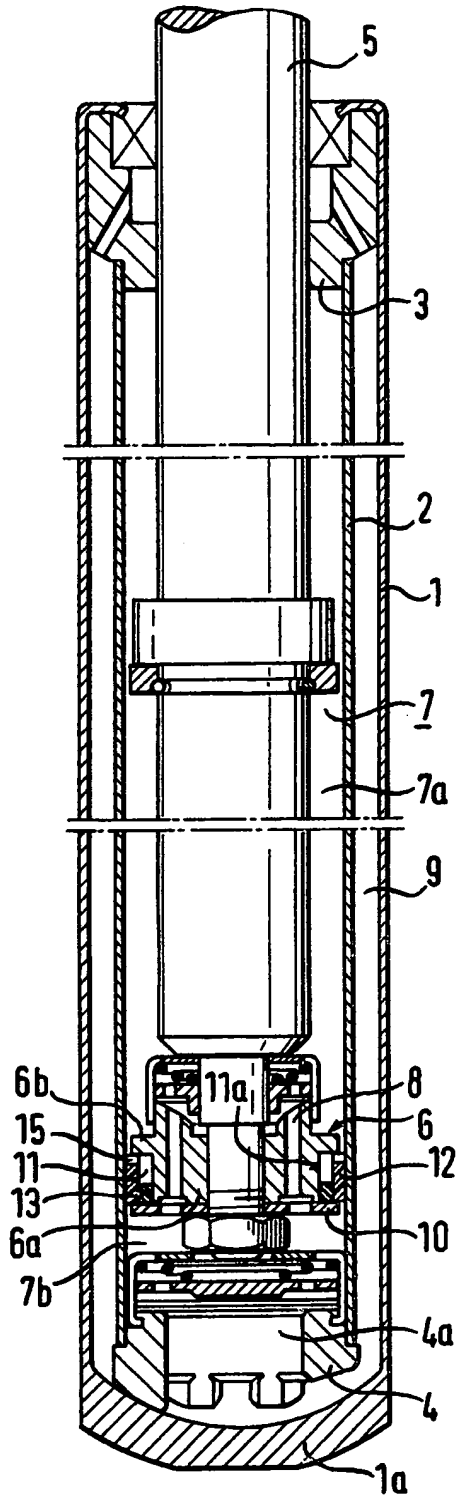

5
3
2
1
7
7a
9
6b
11a
8
15
6
11
12
13
6a
10
7b
4a
4
1a

FIG.1A

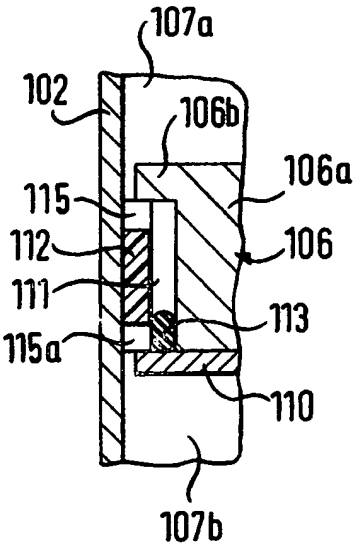

107a
102
106b
106a
115
112
106
111
113
115a
110
107b

FIG. 2

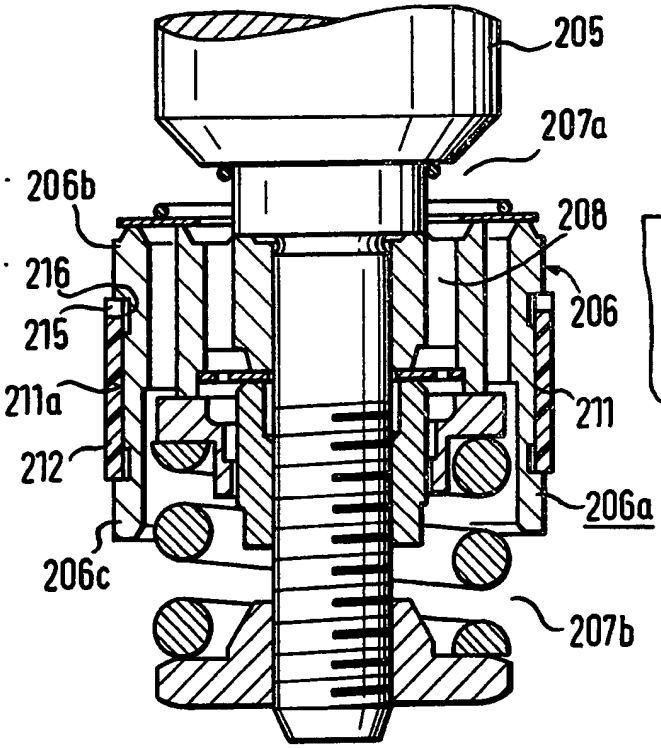


FIG. 3

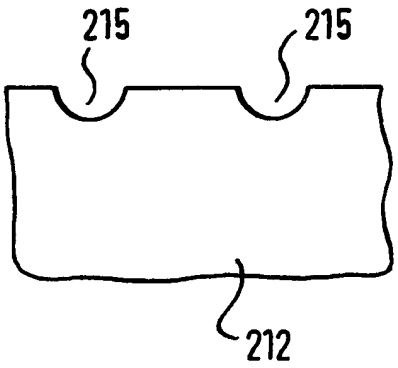


FIG. 4

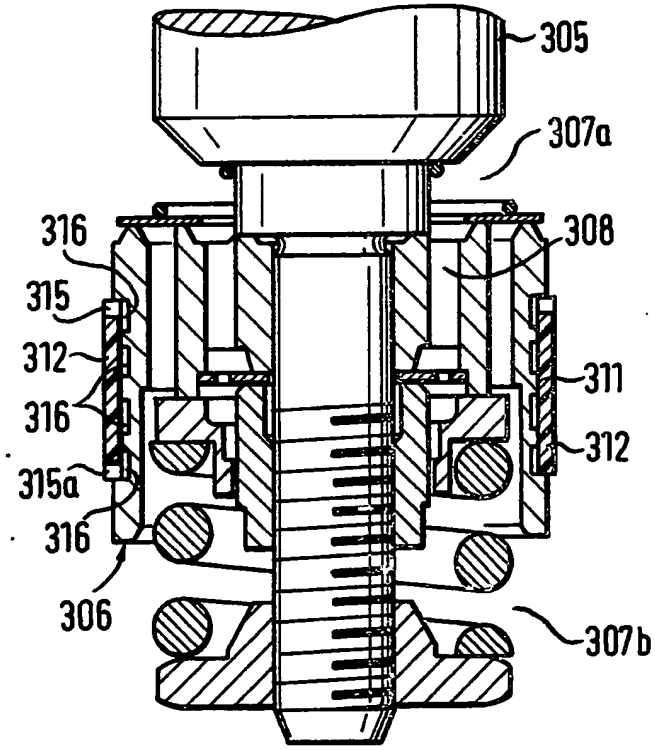


FIG. 5

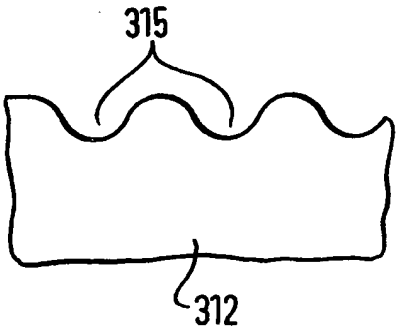


FIG.6

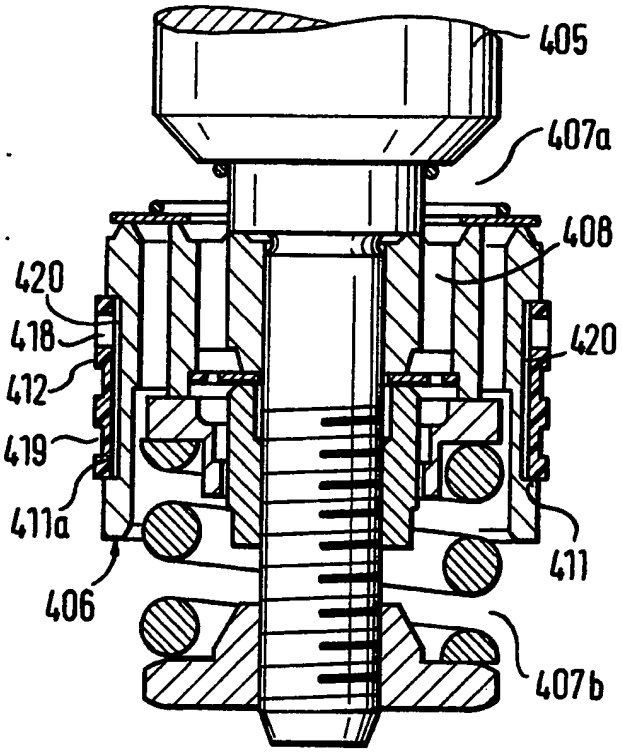


FIG.7

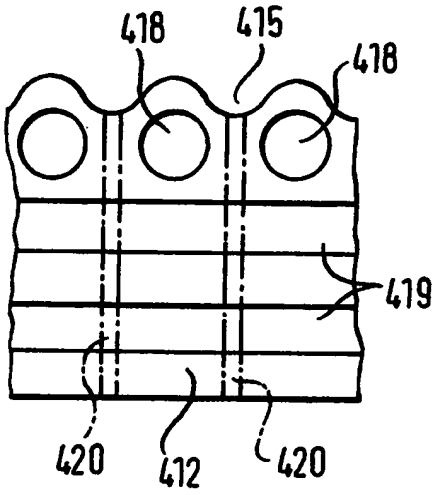
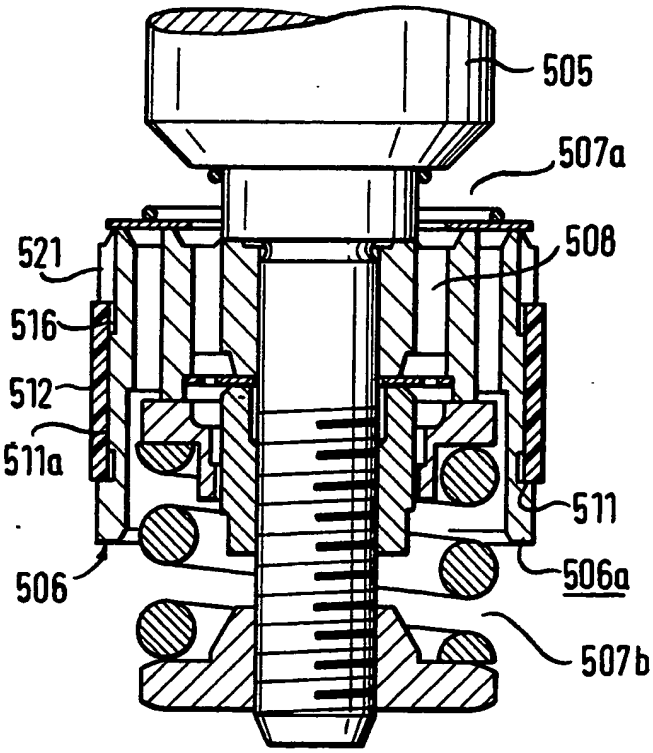


FIG.8



SPECIFICATION
A cylinder piston device

The present invention relates to a cylinder piston device which is particularly suitable for use as part of a shock absorber or part of a spring suspension unit (telescopic strut) of a vehicle.

It is known to have a cylinder piston device comprising a cylinder member having an axis and two ends defining a cavity therein, a piston rod unit comprising a piston rod member axially movable with respect to the cylinder member, a portion of the piston rod member being housed within the cavity, a piston unit being fixed to the portion of the piston rod member within the cavity, the piston unit defining two working chambers within the cavity, the working chambers being interconnected by throttled fluid connection means, the piston unit being provided with an annular recess in its radially outer circumferential surface facing the inner circumferential surface of the cylinder member, a piston ring member being housed in the annular recess, the piston ring member being made of an elastically deformable material and being in engagement with the inner circumferential face of the cylinder member, and a fluid being contained within the working chambers.

When the piston rod unit is axially moved with respect to the cylinder member, a pressure differential occurs between the two working chambers. It is frequently desired that on occurrence of such a pressure differential, no leakage of fluid occurs between the working chambers at least in one direction. A cylinder piston device of this type (hereinafter referred to as a "cylinder piston device of the type defined") is known, forexample, from German Gebrauchsmuster 77 25 888. In known cylinder piston devices of the type defined the piston ring member must be compressed with a relatively high radial compression force between the radially directed bottom face of the annular recess and the inner circumferential face of the cylinder member so that a good sealing action is achieved between the piston ring member and the inner circumferential face of the cylinder member. This is particularly necessary in view of temperature variations to which the cylinder piston device is subjected, so that a good sealing action is not only achieved with the normal working temperature but also under high and low temperatures to which the cylinder piston device may be subjected. The problem becomes even more difficult, if radial compression forces are to be expected between the piston unit on the one hand and the inner circumferential face of the cylinder member on the other hand. This situation arises particularly with shock absorbers and spring suspension units of vehicles which are to transmit transverse forces from the respective wheel of the vehicle to the structure of the vehicle. In such a case the piston ring members are manufactured by materials which on the one hand are capable of transmitting high radial pressure between the piston unit and the inner circumferential face of the cylinder member, and which on the other hand must have good guiding properties. It is also to be considered that the elastic material which can be used for manufacturing the piston ring members are subject to a greater thermal expension and contraction that the metallic materials used for manufacturing other parts of the cylinder piston device. This is especially true for plastic piston ring members for example piston ring members made of polytetrafluorethylene. In view of this difference in the thermal expansion coefficient a clamp action may occur between the piston ring member and the inner circumferential surface of the cylinder member and a irreversible deformation of the piston ring members may occur when the piston cylinder device is subjected to increased operational temperature. As a consequence thereof the sealing action between the piston unit and the inner circumferential face of the cylinder member becomes defective, when the cylinder piston device later on works under lower temperature. Moreover a noise is to be expected in view of lost motion between the piston unit and the inner circumferential face of the cylinder member.

From German Offenlegungsschrift 27 16 927 it is known that the piston ring comprises a metallic carrier member which is coated only on its outer circumferential face with a layer of plastic material. This known construction is subject to the same problems as defined above.

According to the present invention there is provided a cylinder piston device of the type defined in which at least one fluid chamber is provided radially between the piston ring member and the piston unit and fluid passage means are provided between one of the working chambers and the fluid chamber such that on increase of pressure of the fluid in the one working chamber, the piston ring member is urged by the fluid contained in the fluid chamber radially outward towards the inner circumferential face of the cylinder member.

According to this invention the sealing action of the piston ring member is increased when a high pressure differential occurs between said working chambers so that under conditions in which a good sealing action is desired, a good sealing action occurs and under normal operational conditions the friction between the piston ring member and the inner circumferential surface of the cylinder member may be relatively small and the piston ring member is subject only to little wear. In case of shock absorbers the piston ring member is only slightly pressed against the inner circumferential surface of the cylinder member, when the piston rod unit moves slowly with respect to the cylinder member and on the other hand the piston ring member is pressed with higher radial force against the inner circumferential face of the cylinder member, when fast movements of the piston rod unit with respect to the cylinder member occur.

The various features of novelty which

characterize the invention are pointed out with particularity in the claims annexed and forming a part of this disclosure.

By way of example, six embodiments of a cylinder piston device according to the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a sectional view of a cylinder piston device to be used in connection with a spring suspension unit or a telescopic strut of a vehicle;

Figure 1a is an enlarged sectional view according to Figure 1 showing the engagement of the piston ring member and the inner circumferential surface of the cylinder member, the piston unit being a modified embodiment of that shown in Figure 1;

Figure 2 shows a second modified embodiment of the piston unit;

Figure 3 shows a detail of the piston ring member of Figure 2;

Figure 4 shows a third modified embodiment of the piston unit;

Figure 5 shows a detail of Figure 4;

Figure 6 shows a fourth modified embodiment of the piston unit;

Figure 7 shows a detail of the piston ring member of Figure 6;

Figure 8 shows a fifth modified embodiment of the piston unit.

Fig. 1 shows a cylinder piston device of this invention forming a part of a spring suspension unit or a telescopic strut. The cylinder piston device of Fig. 1 is to be inserted into an outer container (not shown) of such a spring suspension unit or telescopic strut.

The cylinder piston device comprises a tubular container 1. Within this tubular container 1 there is provided a cylinder member 2. The cylinder member 2 is provided at its lower end in Fig. 1 with a bottom member 4. The bottom member 4 is in contact with a bottom wall 1a of the tubular container 1. A piston rod sealing and guiding unit 3 is inserted into both the upper end of the cylinder member 2 and the upper end of the tubular container 1. The cylinder member 2 is centered with respect to the tubular container 1 by the bottom member 4 and the piston rod guiding and sealing unit 3. The cylinder member 2 is under axial compressive tension between the bottom wall 1a and the piston rod guiding and sealing unit 3. A cavity 7 is defined within the cylinder member 2 between the bottom member 4 and the piston rod guiding and sealing unit 3. An annular chamber 9 is defined between the cylinder member 2 and the tubular container 1.

A piston rod member 5 extends inward and outward of the cavity 7 within the cylinder member 2 through the piston rod guiding and sealing unit 3. A piston unit 6 is provided at the inner end of the piston rod member 5. The cavity 7 is subdivided by the piston unit 6 into two working chambers 7a and 7b. The working chambers 7a and 7b are interconnected by throttled fluid connection means 8 passing through the piston unit 6 in substantially axial direction. The working chamber 7b is connected to the annular chamber 9 by throttled passage means 4a extending through the bottom member 4. The working chambers 7a and 7b are filled with an hydraulic liquid. The annular chamber 9 is partially filled with this hydraulic liquid while the remainder of the annular chamber 9 is filled with a gas. This gas may be under atmospheric or under superatmospheric pressure.

The piston unit 6 comprises a piston member 6a. The piston member 6a comprises an upper side wall 6b. To the lower end of the piston member 6a there is fixed a disk member 10, said disk member 10 defining a lower side wall. Between the lower side wall 10 and the upper side wall 6b there is defined an annular recess 11 having a substantial cylindrical bottom face 11a. In the recess 11 there is housed a piston ring member 12, the axial length of which is equal to the distance between the side walls 10 and 6b. The piston ring member 12 is therefore axially fixed between the side walls 10 and 6b. The outer diameters of the side walls 10 and 6b are smaller than the diameter of the inner circumferential face of the cylinder member 2 so that annular gaps are defined between the side walls 10 and 6b on the one hand and the inner circumferential face of the cylinder member 2 on the other hand.

In the recess 11 there is provided between the bottom face 11a and the piston ring member 12 an annular sealing member 13. The piston ring member 12 is made of plastic material, for example of polytetrafluorethylene. The annular sealing member 13 is made of a relatively weak material, for example rubber like materials. The annular sealing member 14 is radially compressed between the bottom face 11a and the piston ring member 12. In the upper terminal face of the piston ring member 12 there are provided recesses 15. These recesses 15 define fluid passage means between the working chamber 7a and the annular chamber which is defined in the recess 11 between the bottom face 11a and the radially inner circumferential face of the piston ring member 12.

In operation when the piston rod 5 is pulled upwards with respect to the cylinder member 2 the pressure of the liquid contained in the working chamber 7a is increased as compared with the pressure of the liquid contained in the working chamber 7b. The increase of the pressure in the working chamber 7a is transmitted also through the fluid passage means 15 to the annular chamber defined between the piston ring member 12 and the bottom face 11a in the recess 11. By this increased pressure the piston ring member 12 is urged in radially outward direction towards the inner circumferential surface of the cylinder member 2. So the sealing action of the piston ring member 12 with respect to the inner circumferential surface of the cylinder member 2 is increased. No liquid can pass between the piston ring member 12 and the inner circumferential face of the cylinder member 2. Simultaneously the annular sealing member 13 is

compressed in axial direction by the pressure of the liquid towards the side wall 10 so that no liquid can escape between the lower terminal face of the piston ring member 12 and the side wall 10.

Under normal conditions when the pressure in the working chamber 7a is substantially equal to the pressure in the working chamber 7b the friction between the piston ring member and the inner circumferential face of the cylinder member 2 is relatively small so that the piston ring member 12 is not subject to substantial wear.

It is to be noted that in the embodiment of Figure 1 the piston ring member 12 is urged towards the inner circumferential face of the cylinder member 2 only when the piston rod member 5 is pulled upward in axial direction with respect to the cylinder member 2 and not when the piston rod member 5 moves downward with respect to the cylinder member 2. Therefore the sealing action of the piston ring member 12 is less efficient during the latter type of movement. This is, however, tolerable because during a downward movement of the piston rod member 5 the increase of pressure in the working chamber 7b is smaller due to the passage of liquid from the working chamber 7b to the annular chamber 9 through the passage 4a.

In Fig. 1a there is shown a slightly modified embodiment as compared with the embodiment of Fig. 1. Analogous parts are designated by the same reference number as in Fig. 1 increased by 100. The only difference as compared with the embodiment of Fig. 1 consists in that the piston ring member 112 is provided with at least one recess 115a also at its downward directed terminal face. As a consequence thereof when the piston member 106 moves downward, and the pressure of the liquid correspondingly increases in the working chamber 107b, the annular sealing member 113 is moved upward so as to close the recess 115. Therefore in this embodiment the piston ring member 112 is urged in radial direction toward the inner circumferential face of the cylinder member 102 on increase of the pressure in the working chamber 107a as well as on increase of the pressure in the working chamber 107b.

In the embodiment of Figures 2 and 3 analogous parts are designated by the same reference numbers as in Fig. 1 increased by 200.

The recess 211 is confined in axial direction by two side walls 206b and 206c both integral with the piston member 206a. In the piston member 206a there is provided adjacent the upper side wall 206b an annular groove in the bottom face 211a which annular groove 216 is adjacent the side wall 206b. The recesses 215 are distributed along the periphery of the upper terminal face of the piston ring member 212 as shown in Fig. 3.

When the pressure in the working chamber 207a increases, the pressure of the liquid increases also within the annular groove 216 so that the upper axial portion of the piston ring member 212 overlapping the annular groove 216 is urged in radially outward direction with the same result as described in connection with Figures 1 and 1a.

In the embodiment as shown in Figures 4 and 5 a plurality of annular grooves 216 are provided in the bottom face 311a of the annular recess 311. The recesses 315 in the upper terminal face of the piston ring member 312 define undulated terminal face.

The same is true for recesses 315a which define an undulated terminal face at the lower terminal end of the piston ring member 312.

When the pressure in the working chamber 307a increases the pressure increases also in the uppermost annular groove 316 so that the upper axial portion of the piston ring member 312 overlapping the uppermost annular groove 316 is urged radially outward. When, however, the pressure increases in the working chamber 307b, the pressure increases also in the lowermost annular groove 316 so that the lower terminal section of the piston ring member 312 overlapping the lower annular groove 316 is urged in radially outward direction.

In the embodiment as shown in Figures 6 and 7 analogous parts are designated with the same reference numbers as in Fig. 1 increased by 400.

As shown in Figures 6 and 7 there are provided axial grooves 420 in the bottom face 411a of the recess 411. As indicated in Fig. 7 the axial grooves 420 provided in the bottom face 411a of the recess 411 are in substantial alignment with the recesses 415 which are provided in the upward directed terminal face of the piston ring member 412. So the axial grooves 420 are connected to the upper working chamber 407a and a pressure increase occurring in the upper working chamber 407a is transmitted also to the axial grooves 420. Therefore on such occurrence of increased pressure in the working chamber 407a, the piston ring member 412 is urged in radially outward direction.

As can be seen from Fig. 6 and 7 there are provided substantially radial bores 418 in the piston ring member 412. These radial bores 418 have a double function. First by the radial bores liquid is admitted to the inner circumferential face of the cylinder member so that an improved lubrication is achieved. Second due to the radial bores 418 the axial compressibility of the piston ring member 412 is enhanced so that the positioning of the piston ring member 412 into the recess 411 is facilitated. Moreover the piston ring member 412 when positioned within the recess 411 is fixed between the side walls of the recess 411 without lost motion.

In the embodiment of Fig. 8 analogous parts are designated by the same reference number as in Fig. 1 increased by 500.

As can be seen from Figure 8 there are provided axial grooves 521 in the piston member 506a. These axial grooves 521 open into an annular groove 516 provided in the bottom face 511a adjacent the upper axial end of the recess 511. By the axial grooves 521 the annular groove 516 is in communication with the upper working

chamber 507a so that an increase of pressure in the working chamber 507a is transmitted also to the annular groove 516 and the piston ring member 512 is urged in radial outward direction in its upper portion overlapping the annular groove 516.

The advantage of this latter embodiment is that no recesses are necessary in the upper terminal face of the piston ring member 512. The piston ring member 512 can therefore be positioned in both axial orientations onto the piston member 506. This facilitates assembling of the piston unit.

With respect to Fig. 6 and 7 it is to be noted still that there are annular grooves 419 provided in the outer circumferential face of the piston ring member 412. By such annular grooves 419 the friction between the piston ring member 412 and the inner circumferential face of the cylinder member can further be reduced.

It is to be noted that in all embodiments a very small radial outward movement of the piston ring member 12, 112, 212, 312, 412, 512, is sufficient for improving the sealing action of the piston ring member with respect to the inner circumferential face of the cylinder member. Therefore no leakage can occur between the piston ring member and the piston member. Please note that in Fig. 1, 2, 3, 6, 7 and 8 the piston ring member engages with its lower terminal face the lower side wall of the recess for example the side wall 206c in Fig. 2. When the piston member 206 is moved upwards as shown in Fig. 2 both the friction of the piston ring member 212 with respect to the inner circumferential face of the cylinder member and the increased pressure acting on the upper terminal face of the piston ring member 212 urge the lower terminal face of the piston ring member 212 against the lower side wall 206c so that the sealing action at the lower end of the piston ring member 212 is improved.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the inventive principles it will be understood that the invention might be embodied otherwise without departing from such principles. In particular it is to be noted that the features of the different embodiments of this invention can be combined. For example the axially directed grooves 521 of Fig. 8 can be combined with the axial grooves 420 of Fig. 6 and 7. Further it is possible to provide in the embodiment of Fig. 8 an annular sealing member comparable to the sealing member 13 of Fig. 1.

It is further to be noted that the piston ring member can also comprise a metallic carrier which is coated on its external circumferential face with a plastic coating. This is particularly true for the embodiments of Fig. 1 and 1a. The metallic carrier sleeve can be made of thin sheet material so that the increased pressure on the radial inner side of the piston ring member is sufficient to expand the carrier sleeve to the necessary extent.

An advantage of a cylinder piston device according to the present invention is that it comprises a piston ring member which provides the desired sealing action, at least in one direction, between the two working chambers of the cylinder member when a high pressure differential occurs between the two working chambers, whilst the frictional force between the piston ring and the inner circumferential surface of the cylinder member is relatively low at other times. At fast speeds of the piston rod unit, the piston ring member is pressed tightly into contact with the inner circumferential surface of the cylinder member, thereby forming a good sealing action between the two working chambers. At slower speeds of the piston rod unit, the radial outward pressure on the piston ring member urging it into contact with the inner circumferential surface of the cylinder member is only relatively small, and therefore the piston ring member is subjected to a minimum of wear and can be used over long periods of operation.

CLAIMS

1. A cylinder piston device comprising a cylinder member having an axis and two ends defining a cavity therein, a piston rod unit with a piston rod member axially movable with respect to said cylinder member, a portion of said piston rod member being housed within said cavity, a piston unit being fixed to said portion of said piston rod member within said cavity, said piston unit defining two working chambers within said cavity, said working chambers being interconnected by throttled fluid connection means, said piston unit being provided with an annular recess in its radially outer circumferential surface facing the inner circumferential surface of said cylinder member, a piston ring member being housed in said annular recess, said piston ring member being made of an elastically deformable material and being in engagement with said inner circumferential face of said cylinder member, and a fluid being contained within said working chambers, wherein at least one fluid chamber is provided radially between said piston ring member and said piston unit, and fluid passage means are provided between one of said working chambers and said fluid chamber such that on increase of pressure of said fluid in said one working chamber, the piston ring member is urged by the fluid contained in said fluid chamber radially outward towards said inner circumferential face of said cylinder member.

2. A cylinder piston device as claimed in claim 1, wherein said piston ring member is axially fixed with respect to said piston unit.

3. A cylinder piston device as claimed in claim 1 or claim 2, wherein said piston ring member is axially fixed between axially opposed side walls of said annular recess.

4. A cylinder piston device as claimed in claim 1, claim 2 or claim 3, wherein the axial length of said piston ring member is at least equal to the radial thickness of said piston ring member.

5. A cylinder piston device as claimed in claim 1, claim 2 or claim 3, wherein the axial

length of said piston ring member is at least twice the radial thickness of said piston ring member.

6. A cylinder piston device as claimed in claim 1, claim 2 or claim 3, wherein the axial length of said piston ring member is at least three times the radial thickness of said piston ring member.

7. A cylinder piston device as claimed in any preceding claim, wherein the outer diameter of at least one of said side walls is smaller than the diameter of said inner circumferential face of said cylinder member so as to define a gap being a part of said fluid passage means.

8. A cylinder piston device as claimed in any preceding claim wherein said fluid chamber is an annular fluid chamber, radially interposed between a radially outwardly directed bottom face of said annular recess and a radially inwardly directed inner circumferential face of said piston ring member.

9. A cylinder piston device as claimed in any preceding claim wherein said fluid passage means comprise at least one recess provided in a substantially axially directed terminal face of said piston ring member.

10. A cylinder piston device as claimed in any preceding claim wherein said piston ring member is provided with at least one substantially radially directed bore communicating with said fluid chamber and opening towards said inner circumferential face of said cylinder member.

11. A cylinder piston device as claimed in any one of claims 1 to 9 wherein at least one fluid chamber is provided adjacent respective axial ends of said piston ring member, said fluid chambers being connected with the respective working chambers by respective fluid passage means.

12. A cylinder piston device as claimed in claim 8, wherein an annular sealing member is provided within said annular fluid chamber, adjacent the end thereof, which is remote in axial direction from said one working chamber.

13. A cylinder piston device as claimed in claim 8, wherein an annular sealing member is provided within said annular fluid chamber, said annular sealing member being axially movable between respective axial ends of said annular fluid chamber in response to pressure differentials existing between said working chambers such that said annular fluid chamber is in fluid connection by respective fluid passage means with the one working chamber or the other working chamber according to the direction of the pressure drop between said working chambers.

14. A cylinder piston device as claimed in any one of claims 1 to 10 wherein a plurality of fluid chambers is defined by substantially axially extending grooves worked into a substantially radially outwardly directed bottom face of said annular recess.

15. A cylinder piston device as claimed in any one of claims 1 to 8 wherein said fluid passage means comprises at least one substantially axially extending groove in the outer circumferential face of said piston unit, said substantially axially extending groove extending in axial direction beyond the respective axial end of said piston ring member.

16. A cylinder piston device as claimed in claim 8, wherein said annular fluid chamber is defined by an annular groove provided in the radially outwardly directed bottom face of said recess and extending in the axial direction only over part of the axial length of said recess.

17. A cylinder piston device as claimed in claim 16, wherein said annular groove in said bottom face of said recess is adjacent an axial end of said recess.

18. A cylinder piston device as claimed in any one of claims 1 to 8 wherein at least one annular groove is provided in the radially outer circumferential face of said piston ring member.

19. A cylinder piston device as claimed in any preceding claim wherein said fluid connection means transverse said piston unit in a substantially axial direction.

20. A cylinder piston device as claimed in claim 9, wherein a plurality of recesses is defined in said axially terminal face around the periphery of said axial terminal face such that said axially terminal face has an undulated configuration.

21. A cylinder piston device as claimed in any preceding claim wherein said cylinder member is provided with a piston rod guiding and sealing unit at one end thereof and with bottom member at the other end thereof, a first working chamber being defined adjacent said guiding and sealing unit and a second working chamber being defined adjacent said bottom member, said second working chamber being connected by throttled passage means to a fluid reservoir, said fluid chamber being connected by said fluid passage means to said first working chamber.

22. A cylinder piston device as claimed in any preceding claim wherein said cylinder member is surrounded by a tubular container member, said fluid reservoir being defined by an annular space defined in radial direction between said cylinder member and said tubular container.

23. A cylinder piston device substantially as hereinbefore described with reference to and as shown in Figure 1 or in Figure 1 as modified by Figure 1A or in Figures 2 and 3 or in Figures 4 and 5 or in Figures 6 and 7 or in Figure 8 of the accompanying drawings.

24. A shock absorber for a vehicle having a cylinder piston device as claimed in any preceding claim.

25. A spring suspension unit for a vehicle comprising a cylinder piston device as claimed in any one of claims 1 to 23.

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